Prepared for

Settling Work Defendants

DRAFT FIELD SAMPLING PLAN FOR THE LEADING EDGE INVESTIGATION

Omega Superfund Site
Operable Unit 2

Prepared by

Geosyntec consultants

engineers | scientists | innovators

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Project Number: WR2209

9 September 2016

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

2016 CD	Consent Decree lodged April 20, 2016 covering Operable Unit 2 at the Omega Chemical Corporation Superfund Site
ASTM	American Society for Testing and Materials
CSRS-H	California Spatial Reference System Horizontal
CMP	Compliance Monitoring Plan
COCs	Chemicals of Concern
DO	dissolved oxygen
DQOs	data quality objectives
DTSC	California Department of Toxic Substance Control
EC	electrical conductivity
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
Geosyntec	Geosyntec Consultants, Inc.
HASP	Health and Safety Plan
ID	inner diameter
IDW	investigation derived waste
LEI	Leading Edge Investigation
Main COCs	13 COCs identified in the ROD as “main COCs” and listed in Table 1 of the LEI Work Plan. Includes eleven VOCs, 1,4-dioxane, and hexavalent chromium. The Main COCs are included in the COC list for the RD.
ml	milliliter
ml/min	milliliters per minute
mS/cm	millisiemens per centimeter
mV	millivolts
NTU	Nephelometric turbidity unit

ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OU2	Operable Unit 2
PID	photoionization detector
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RQD	rock quality designation
SOPs	Standard Operating Procedures
SOW	Statement of Work, Appendix B to the 2016 CD.
SWDs	Settling Work Defendants, as identified in Appendix E to the 2016 CD. SWDs include the McKesson Corporation and OPOG (Omega Chemical Corporation Superfund Site Potentially Responsible Party Organized Group).
TOC	total organic carbon
USCS	Unified Soil Classification System
USA	Underground Service Alert
VOCs	volatile organic compounds
Work Area	The portions of OU2 that are the subject of Work under the 2016 CD and the SOW.

1. INTRODUCTION

This Field Sampling Plan (FSP) was prepared by Geosyntec Consultants, Inc. (Geosyntec) on behalf of the Settling Work Defendants (SWDs) for the Omega Chemical Corporation Superfund Site, Operable Unit 2 (OU2), shown in Figure B-1. This FSP was prepared in accordance with Section 7.7c of the Statement of Work (SOW), Appendix B of the Consent Decree (2016 CD) for Operable Unit 2 (OU2) at the Omega Chemical Corporation Superfund Site (United States Environmental Protection Agency (EPA), 2016). This FSP describes the procedures to be used for field activities to be conducted as part of the Leading Edge Investigation (LEI) (Figure B-2).

2. PRE-FIELD ACTIVITIES

2.1 Permitting and Access

Prior to the start of LEI activities, the SWDs will obtain the necessary well installation permits, property access agreements, and encroachment permits, and will prepare a Health and Safety Plan (HASP). Traffic control plans will be developed and will include appropriate provisions for signage, lane closure, and egress into driveways, as necessary. To the extent possible, new monitoring wells will be located in public rights-of-way. If circumstances dictate that private property is more suitable for a well location, then permission to install the well on the private property will be sought.

2.2 Health and Safety

The HASP (Appendix C of the LEI) has been prepared in accordance with local, state, and federal requirements to encompass the LEI field activities. The objective of the HASP is to present safety protocols to ensure that all operations are conducted in a manner that protects worker safety and meets compliance with Occupational Safety and Health Administration (OSHA) regulations and EPA safety policies. Field activities will be performed by individuals with appropriate training (CFR 1910.120), in accordance with the HASP.

Contractors selected to conduct the LEI fieldwork will prepare their own HASPs to encompass their individual field activities. Before field activities commence, the HASP will be reviewed and signed by the field personnel. The HASP will contain information pertaining to field conditions, potential hazards, hazard control, monitoring procedures, personal protective equipment, emergency procedures, and hospital location. The HASP will be available in the field for the field personnel during all LEI field activities. Unless specified otherwise in the HASP, field personnel will generally work in modified Level D personal protective equipment.

A safety tailgate meeting will be conducted every day prior to the start of field activities.

2.3 Underground Utility Clearance

Prior to the selection of logistically feasible monitoring well cluster locations, the exploratory boring and well locations will be marked with white paint, and

Underground Service Alert (USA) will be notified at least 48 hours prior to drilling work. A private utility locator will perform a physical survey to clear potential subsurface utilities, pipelines, or other obstructions prior to drilling work. The physical survey will be conducted with ground penetrating radar, radio-detection electromagnetic utility locator, and metal detector.

3. DRILLING

Boreholes drilled for the placement of monitoring wells will also be used to characterize subsurface conditions. Wells will be constructed after lithologic data and geophysical data have been obtained and reviewed. Well drilling, lithologic logging, and construction will be conducted under the supervision of a California Professional Geologist.

3.1 Equipment and/or Instrumentation

Well borings will be drilled using mud rotary or sonic drilling methods, as appropriate. For wells constructed using mud rotary techniques, a suite of geophysical logs will be obtained prior to deep well construction.

3.2 Preparation

A qualified driller will be selected to drill the well borings. A qualified driller will have appropriate equipment capabilities, a California C-57 license, experience on similar projects, and documentation of health and safety training. This experience requirement shall apply both to the individual driller in the field and to the drilling company as a whole.

Prior to entering the field, authorized personnel will contact property owners and applicable agencies to obtain and comply with regulatory requirements regarding permits, access, drilling, and underground utility clearance.

3.3 Procedures

Well borings will be drilled using mud rotary or sonic drilling methods, as appropriate. Upon reaching total depth, and after lithologic and geophysical logging have been completed, the boring will be converted to a monitoring well (Section 6). It may be necessary to enlarge the borehole by reaming in order to accommodate the well casing and other well construction materials in accordance with design requirements.

3.4 Equipment Decontamination and Waste Disposal

All downhole drilling equipment will be steam cleaned and maintained in a clean condition prior to commencing drilling operations at each drilling location.

All materials generated during drilling activities will be contained, labeled, and temporarily stored in 55-gallon drums, roll-off bins, and/or Baker-type portable tanks until an appropriate disposal option is determined. This includes all drilling fluid, drill cuttings, and wash and rinse water. Procedures for handling, storage, characterization, and disposal of investigation derived waste (IDW) are presented in Section 11.

3.5 Documentation

A log of conditions encountered during drilling will be maintained by field personnel. The log will include lithologic and hydrogeologic descriptions, as well as notations on drilling characteristics and conditions encountered during drilling. Field lithologic descriptions will be based on examination of drill cuttings with consideration of impacts of the drilling process on cuttings. Logging will be supervised by a California Professional Geologist. Lithologic logs will be prepared according with Section 4 of this FSP. Documentation will be compiled for each boring and will include the following:

- Lithologic log of drill cuttings in a field notebook. Lithologic descriptions for soil will follow the Unified Soil Classification System (USCS) procedures (U.S. Department of Interior, 1998).
- Field notes compiled by the on-site field personnel during drilling operations.
- Geophysical logs.
- Photographs, if available.

Final logs will be prepared based on all available information, including drill cuttings and geophysical logs. Drill cutting samples will be retained until the lithologic log is finalized.

3.6 Quality Assurance

Quality assurance (QA) during drilling, sampling, and logging of boreholes will be accomplished by following this FSP. In addition, the Project Manager and the supervising California Professional Geologist will review all lithologic logs and drilling documentation throughout drilling operations to ensure conformity with this FSP.

4. LITHOLOGIC LOGGING

A log of the conditions encountered during drilling of monitoring well borings will be maintained. The log will include lithologic and hydrogeologic descriptions along with notations on drilling activities and conditions encountered during drilling. Lithologic logging will be conducted by experienced field personnel under the direction of a California Professional Geologist.

4.1 Equipment and/or Instrumentation

Equipment used as part of lithologic logging may include any or all of the following: hand lens, dropper bottle containing dilute hydrochloric acid, Munsell color chart, sand size chart, sample collection bags, cuttings trays, wire mesh sieves, organic vapor monitoring devices, photoionization detector (PID), and a pocket knife. Reference materials such as USCS [American Society for Testing and Materials (ASTM), D 2488 – 00, 2000], American Geologic Institute Data Sheets for Field Geology (Walker and Cohen, 2009), Manual of Field Geology (Compton, 1962), or Earth Manual (U.S. Department of Interior, Bureau of Reclamation, 1998) may be used.

4.2 Preparation

Essential field equipment and supplies will be ordered prior to commencing lithologic logging. Available references relating to the LEI such as lithologic logs, geologic reports, and other information from previous assessments will be reviewed.

4.3 Procedures

A lithologic log will be compiled during drilling of well borings. The following procedures will be used during lithologic logging activities:

- Describe the soil/rock sample or drill cuttings and record in field notebook. Take into account alterations caused by the sampling or drilling process.
- Note unusual drilling conditions or rig behavior.

The following procedures will be used for lithologic description of drill cutting samples:

- Textural Classification of Soil:

- Record the approximate ratio of the following grain size fractions present in the sample: gravel, sand, silt, and clay. The size limits for each fraction will be in accordance with the USCS (ASTM, 2000). Estimate and record the predominant grain size(s) present within the gravel and sand fractions in the sample.
- Provide textural classification name for the soil/sediment and classify the soil/sediment using the USCS. The root of the name is determined by the highest percentage of gravel, sand, silt, or clay fractions. The modifying terms are based on the relative percentage of the other major size fractions in the sample. A major size fraction is defined as a textural fraction that constitutes 30 percent or more of the sample, by volume. For example, a sample containing 90 percent sand and 10 percent silt would be classified as a sand with silt. Record the appropriate USCS classification on the lithologic log form.

- Color:
  - Compare sample to Munsell color chart and provide hue and chroma values for soil samples. Indicate in the field notebook if the color was determined based on a dry sample. Record the Munsell color descriptor.
- Moisture Content:
  - For soil/sediment samples collected using drilling methods that do not involve introduction of fluids, estimate relative moisture content using the terms "dry," “moist,” and “wet”.
- Consistency or Relative Density:
  - Estimate the consistency or relative density of the sample for fine-grained soils based on examination of soil samples. Consistency descriptors for fine-grained soils/sediments are: very soft, soft, firm, hard, and very hard.
- Plasticity:
  - Determine the degree of plasticity for fine-grained lithologic samples. Plasticity is the property in which a soil/sediment can be rapidly deformed or molded without rebounding elastically, changing volume,

cracking, or crumbling (ASTM, 2000). Plasticity descriptors are: nonplastic, low plasticity, medium plasticity, and high plasticity.

- Sorting:
    - Estimate the degree of sorting, or overall grain size distribution, of soil/sediment samples that consist predominantly of sand-sized or larger particles. Designate by using one of the following descriptors: poorly graded, and well graded. The descriptor "well graded" applies to soils/sediments in which there is a good representation of the continuum of particle sizes. The descriptor "poorly graded" applies to soils/sediments in which most particles are about the same size.
- Roundness:
    - Estimate the predominant roundness categories for the sand and gravel size fractions according to the roundness scale. The roundness categories are: angular, subangular, subrounded, and rounded. The on-Site field personnel will record in the field notebook actions of drilling bits or auger flights that may be responsible for increasing the angularity of the sand or gravel size fractions in the sample, if applicable.
- Miscellaneous Properties:
    - Additional properties should be reported if noted in the soil/sediment sample. These properties include the following: mineralogic composition; degree of iron or manganese staining of coarse fraction; reactance with dilute hydrochloric acid; odor; other physical properties, including soil structure and fracture spacing and width, if applicable; orientation and coatings on fractures, if applicable; presence of man-made, animal, or plant material; and organic vapor readings determined using equipment such as an organic vapor analyzer or a PID.

4.4 Documentation

Field personnel will compile lithologic logging descriptions and observations made during drilling activities in the field notebook and the lithologic log.

A project-specific lithologic log form has been developed (Form B-1). In addition to lithologic data, the lithologic log form includes:

- Project name
- Date(s)
- Boring identifier
- Boring location
- Field personnel’s name
- Drilling company's name
- Drill rig operator's name
- Drilling method
- Weather conditions
- Space for remarks and comments

Final lithologic logs will be prepared based on all available information. A copy of the field notebook entries for monitoring well borings will be maintained in the field for reference purposes. One set of the completed documentation forms will also be maintained in the field for reference purposes. The original set of notes and forms will be filed in the project files.

4.5 Quality Assurance

QA during lithologic logging activities will be accomplished by following this FSP. In addition, the Project Manager and the supervising California Professional Geologist will review lithologic logs and drilling documentation throughout drilling operations to ensure conformity with this FSP.

5. GEOPHYSICAL LOGGING

Following drilling of monitoring well borings to total depth, borehole geophysical logs will be obtained at each well cluster location to provide data for evaluating lithology, groundwater conditions, and borehole conditions and to provide rationale for determining appropriate screen intervals for wells within the cluster. Geophysical logs may include the following: spontaneous potential, electrical resistivity, gamma ray, and caliper. Additional geophysical logs, such as borehole deviation or downhole video, may be obtained depending on project requirements.

5.1 Equipment and/or Instrumentation

Borehole geophysical logging will be performed by a qualified geophysical subcontractor. Equipment required will be based on the suite of logs selected. A hard copy of geophysical logs will be recorded on paper. Geophysical logs will also be stored digitally. The logging equipment provided should be capable of being calibrated in the field.

Successful borehole geophysical logging operations depend on adequate planning and close supervision to ensure that equipment is operated properly, the recorded data are accurate, and the log is easily interpretable. Copies of this FSP will be kept onsite by field personnel and will be referred to before, during, and after geophysical logging, as needed.

5.2 Preparation

The following procedures will be performed in preparation for geophysical logging:

- Notify the contracted logging service company at least 24 hours before the anticipated logging period. Estimate required lead time for dispatching the truck. Provide the following information:
    - Company name as it appears on the log header.
    - Consultant's name; name of consultant representative, usually on-Site field personnel; and local office telephone number.
    - Well name/number and location.

- Explicit directions to Site and information on Site access. If access is controlled, arrange a specific time and location to meet the logging truck outside the restricted area.
- Approximate time borehole will be ready for logging and the time required for conditioning the borehole prior to logging.
- Approximate total depth of borehole in feet below land surface (bls) and approximate ground level elevation in feet above mean sea level.
- Borehole dimensions.
- Geophysical logs to be obtained may include:
  - spontaneous potential;
  - electrical resistivity;
  - caliper; and
  - gamma ray.
- Notification of potential health and safety hazards.
- Confirmation and documentation of logging tool calibration.
- Name of, and request for, logging unit and operator used previously on the project.

- As the borehole nears completion, contact the logging service to confirm dispatch of the logging truck. Repeat the earlier information regarding Site location, access, and logs to be obtained.

5.3 Procedures

The following procedures will be used during borehole geophysical logging:

- The field personnel will inform the logging engineer of the desired vertical and horizontal scales. Scales should remain consistent for each logged borehole, if possible.
- Run a repeat section for each well boring.
- Repeat a minimum of 50 to 100 feet.

- Compare the repeat section to the same interval on the total log. Explain discrepancies, generally resulting from a defective tool.
- Compare the logger's total depth to the driller's total depth. Large differences may indicate conditions such as the hole sloughing, driller's measurement error, or incorrect tool depth setting.
- Do not exceed maximum recording speeds.
- Watch for depth control. Curve deflections should generally be on depth with each other.

5.4 Equipment Decontamination and Waste Disposal

Downhole logging cables and tools will be decontaminated with fresh water or a steam cleaner as they exit the borehole. All rinse waters will be stored and properly disposed.

5.5 Documentation

The field personnel will verify that the logging engineer has accurately recorded the following information appropriately on the log header:

- Correctly spelled well identifier and company name.
- Date of logging.
- Depth data, including ground level, logger's total depth, and driller's total depth.
- Logging unit number and engineer name.
- Equipment type and serial number of individual tools.
- Scale and scale changes, noted both on the heading and at the point of change on the log.
- Curve presentation, clear with no gaps or smears.
- All curves clearly labeled on the scale.

5.6 Quality Assurance

QA during geophysical logging activities will be accomplished by following this FSP. The Project Manager and the supervising California Professional Geologist will review geophysical logs and field notes recorded throughout the geophysical logging operations to ensure conformity with this FSP. Additionally, a repeat spontaneous potential run of a minimum of 50 to 100 feet will also provide sufficient QA during geophysical logging activities.

6. MONITORING WELL CONSTRUCTION

The drilling and completion of each monitoring well will be overseen by field personnel under the supervision of the California Professional Geologist responsible for the collection of lithologic and hydrogeologic data; selection of screened intervals; and determination of final well depth. Well design, lithologic logging, soil and groundwater sampling, and well construction will be conducted under the supervision of a California Professional Geologist. Wells will be designed in accordance with EPA guidelines (EPA, 2002) and with applicable County of Los Angeles regulations.

Wells will be installed in groups, or ‘clusters’, in order to characterize water levels and water quality in various targeted hydrogeological units at the same geographic location. The type of drilling equipment will be selected to be most appropriate for a specific target depth to be screened.

Wells will be developed using a combination of conventional surging, bailing, swabbing, and pumping technologies, or using an alternative method approved by the Project Manager and the supervising California Professional Geologist.

6.1 Equipment and/or Instrumentation

The deepest monitoring well in each well cluster will be drilled and constructed using mud rotary, unless conditions warrant another method of construction. Shallower monitoring wells will be drilled and constructed using sonic drilling methods. Wells will be developed, as appropriate, using vented surge blocks, bailing, or pumping until the discharge water is clear and sand-free to the extent practicable.

Dedicated sampling pumps and polyvinyl chloride (PVC) sounding tubes may be installed after well construction. A generator would be used to drive the pumps. Electrical connectors would be installed at each wellhead beneath the steel cover.

6.2 Preparation

A qualified driller will be selected to drill and install the wells. A qualified driller will have appropriate equipment capabilities, a California C-57 license, experience on similar sites, and documentation of health and safety training. This experience requirement shall apply both to the individual driller in the field and to the drilling company as a whole.

Prior to entering the field, authorized personnel will contact property owners and applicable agencies to obtain and comply with regulatory requirements regarding permits, access, drilling, and underground utility clearance, if required.

6.3 Procedures

The deepest monitoring well in each well cluster will be drilled and constructed using mud rotary, unless conditions warrant another method of construction. Shallower monitoring wells will be drilled and constructed using sonic drilling methods. Boreholes for wells will be reamed to an approximate 10-inch diameter, if necessary. A deep exploratory borehole may be converted to a monitoring well by sealing the interval below the proposed screen interval with bentonite grout prior to reaming, if necessary, and well construction

For mud rotary drilling, the field personnel will closely monitor the mud density, viscosity, and sand content to assure proper hydrostatic head, thus preventing cross contamination.

A soil sample collected from, and deemed to be representative, of lithologic units at potential screened interval will be sieved in the field or submitted to a geotechnical laboratory to determine the approximate grain size distribution.

6.3.1 Procedures for Selection Well Screen Intervals

The following will be used to determine the appropriate screen intervals:

- The deepest well in LEI Monitoring Well Clusters 1 and 2 will be screened in the deepest coarse grained layer greater than 5 feet in thickness observed in the exploratory boring to a maximum depth of 500 feet. The deepest coarse grained layer will be identified by the supervising California Professional Geologist supervising the work based on review of the exploratory boring lithologic and geophysical logs. A brief transmittal will be prepared to convey the selected well depth intervals and supporting data to EPA for review and approval.

- Up to four additional well screen intervals will be selected at each of these two LEI monitoring well clusters to be screened in the coarse grained layers that correlate with screen intervals in the Koontz monitoring wells. These layers will be identified by the supervising California Professional Geologist supervising the work based on review of the exploratory boring lithologic and geophysical logs for each LEI monitoring well cluster location and the Koontz well geophysical logs, Koontz well screen intervals, and the hydrogeologic conceptual site models. A brief transmittal will be prepared to convey the selected well depth intervals and supporting data to EPA for review and approval.

- Following installation of LEI Monitoring Well Clusters 1 and 2 and review of the data collected from these wells, the location of LEI Monitoring Well Cluster 3 will be proposed for EPA review and approval. The process for selecting the screened intervals for this cluster will proceed as above.

6.3.2 Well Construction

The following sections present options for monitoring well construction. The final method will be selected by the Project Manager and the supervising California Professional Geologist based on anticipated subsurface conditions and potential for cross contamination of hydrostratigraphic units.

6.3.2.1 Single Pass Mud Rotary or Sonic Wells

Monitoring wells will be constructed with 4-inch inner diameter (ID) steel or schedule 40 or schedule 80 PVC well casing and 0.010- or 0.020-inch factory-slotted schedule 40 or schedule 80 PVC well screen, continuous slot steel wire-wrap screen, or alternate casing chosen by the field personnel in consultation with and approval by the supervising California Professional Geologist. If neat cement/bentonite-cement is used with schedule 40 PVC blank casing and the total length of neat cement/bentonite-cement seal is over 100 feet, the neat cement/bentonite-cement seal placement may need to be conducted in lifts to avoid collapsing the PVC casing. In some cases, the need to install longer neat cement/bentonite-cement seals in a continuous process can be accommodated by using nominal 4-inch ID schedule 80 PVC casing. However, schedule 80 PVC casing will only be considered for wells where the use of sample/hydraulic testing pumps can fit within the smaller ID casing. When using both stainless steel and mild steel casing, extend the stainless steel casing approximately 20 feet above anticipated high water table to minimize galvanic corrosion. Wells completed in mud rotary or sonic boreholes would include the use of stainless steel or PVC centralizers above and below the screened interval. For these wells, stainless steel or PVC centralizers (along PVC or stainless steel casing sections) or mild steel centralizers (along mild steel casing sections) will be placed at 40-foot intervals along blank casing. A filter pack consisting of Monterey sand no finer than Lonestar No. 0-30 for 0.010-inch well screen, or no finer than Lonestar No. 1C for 0.020-inch well screen, will be installed in the annulus between the borehole and the well screen from the total depth of the well to approximately 3 to 5 feet above the top of the screened interval. An approximate 2- to 3-foot thick bentonite seal will be emplaced in the annulus above the filter pack using bentonite pellets. Sufficient time will be allowed for the bentonite to hydrate prior to grouting the remaining annulus. The annulus between the borehole and well casing will be grouted from the top of the bentonite seal to approximately 2 to 3 feet bls using bentonite-cement (up to 5 percent bentonite) mixture, or neat cement. The cement will be tremied down the annular space of the borehole to ensure a competent surface seal. The well will be completed with a locking steel casing installed inside a steel and concrete utility vault or monument cover, depending on the well location, unless regulatory requirements or site conditions warrant alternate surface completion.

Dedicated stainless steel electric submersible pumps may be installed in monitoring wells for purging and sampling groundwater. Pump intakes would be set at approximately 3 feet above the screened interval for each well.

6.3.3 Monitoring Well Development

Monitoring wells will be developed using a combination of conventional surging, bailing, swabbing, and pumping technologies, or using an alternative method approved by the Project Manager and supervising California Professional Geologist.

6.3.3.1 Well Development Equipment

Wells will be developed, as appropriate, using vented surge blocks, bailers, or nondedicated pumps. Equipment used during well development includes discharge and water level measuring devices. A calibrated 5- to 55-gallon container and stopwatch or an in-line flow meter will be used to estimate discharge rates. Water levels will be measured with a water level sounder. Field equipment includes a turbidity meter to measure turbidity, and an Imhoff cone to measure sand content. Water quality parameters will also be measured using appropriate instruments during development pumping (Section 9).

6.3.3.2 Development Procedures

For mud rotary procedures, initial well development will be conducted during the emplacement of the filter pack to ensure that the filter pack has settled. Initial development will consist of bailing the well for a period of at least 1 hour, and until successive soundings of the filter pack have indicated that the filter pack has settled. Initial well development may also include gently surging and swabbing the well. During initial well development, the filter pack will be sounded and additional filter pack sand will be added, as required. For wells constructed using sonic procedures, limited initial development would be conducted if there is evidence of bridging in the filter pack.

Final development of wells will occur within approximately 2 weeks of well completion. Wells will first be bailed to remove drilling mud and sand. Wells will then be surged using a vented surge block, and pumped until the discharge is clear and sand-free to the extent practicable. Water quality parameters including temperature, pH, and electrical conductivity will be monitored in accordance with Section 9. Development procedures may be modified due to conditions encountered.

The total volume of water purged, water quality parameters measured, sand content, water levels, and the development methods used will be recorded in the field notebook.

During routine groundwater sampling activities, the total depth of each monitoring well may be measured to evaluate whether the well requires redevelopment. In the event that sediment buildup in the well casing obstructs approximately 10 percent or more of the well screen, redevelopment of the well will be conducted in accordance with this section. If practicable, redevelopment will be scheduled to occur before the next scheduled sampling of that well.

6.4 Equipment Decontamination and Waste Disposal

All downhole drilling equipment will be steam cleaned prior to commencing drilling operations, and between well locations. All circulation equipment will be flushed with clear water to rinse away residual drilling fluids between well locations. All rinse waters will be stored and will be properly disposed.

All materials generated from drilling activities will be contained, labeled, and stored in 55-gallon drums, roll-off bins, or Baker-type portable tanks. This includes all drilling fluids and cuttings, wash and rinse water, development water, and soil cuttings.

6.5 Documentation

A log of conditions encountered during well drilling, construction, and development will be maintained in the field notebook. A completion report will be compiled for each well. The completion report will include the following:

- Well completion and development report for monitoring wells and lithologic log form (Forms B-1 and B-2).
- Schematic well construction diagram illustrating as-built well construction details (Figure B-3).
- Field notes compiled by field personnel during drilling operations.
- Photographs, if available.

6.6 Quality Assurance

QA during monitoring well construction activities will be accomplished by following this FSP. In addition, the Project Manager and the supervising California Professional Geologist will review all field notes, well completion and development forms, and lithologic logs throughout drilling operations to ensure conformity with this FSP.

7. WELL SURVEYS

Upon completion of well installation activities, the location, top of casing elevations, and the adjacent land surface of new monitoring wells will be surveyed by a State of California Licensed Land Surveyor.

7.1 Equipment and/or Instrumentation

The following list of equipment may be used during surveys. Site-specific conditions existing at the time the survey is performed may warrant addition or deletion of items from this list.

- Survey grade equipment with base station units (Trimble 5700 Global Positioning System receivers or equivalent).
- Personal protective equipment, traffic cones, and safety vests, as needed.
- Hand tools, field log book and marking equipment, as needed.

7.2 Procedures

The survey will be conducted by a State of California Licensed Land Surveyor. The survey equipment will be tested prior to going in the field to ensure that it works properly and meets the accuracy requirements of the project.

For each monitoring well, the Land Surveyor will determine a horizontal and vertical position at the top of casing and a vertical position at the land surface adjacent to the well. Generally, the north side of the casing will be used as the reference point unless the casing already has a reference point marked or notched on the casing.

Consistent with requirements for the state of California, latitude and longitude will be determined with Third Order methods using a minimum of 2 reference points: California Spatial Reference System Horizontal (CSRS-H) or 2 horizontal geodetic control points derived from the CSRS-H. Monitoring well locations will be tied into NAD83 UTM Zone 11 datum horizontally and NAVD88 datum vertically. All survey data will be referenced to a known reference point.

To meet California requirements, the horizontal position accuracy will be ≤ 100 centimeters. The vertical accuracy for relative elevations of locations in the Work Area will be < 0.01 foot. The vertical accuracy of the absolute elevation (tied to the vertical datum) may be greater than 0.1 foot. The top of casing elevations and the adjacent land surface for the wells will be surveyed relative to mean sea level and subsequent measurements of depth to water will be referenced to these data.

7.3 Documentation

The Land Surveyor will provide a written record of the horizontal location, vertical top of casing elevations, and the vertical position of the adjacent land surface of the monitoring wells. Latitude and longitude measurements will be converted to northings and eastings and reported to seven decimal places.

7.4 Quality Assurance

QA during well surveying activities will be accomplished by adhering to industry established standards for well surveying as well as to the established accuracy requirements. The Licensed Land Surveyor will review all survey data and field notes recorded throughout the well surveying activities to verify conformity with this FSP, industry standards, and Site-specific accuracy requirements. The field personnel will review the data to confirm that it meets the project goals.

8. WATER LEVEL MEASUREMENT

Water levels will be measured in the monitoring wells specified in Table B-1. Proposed monitoring well locations are shown in Figure B-2. Resulting depth-to-water data will be recorded and used in conjunction with surveyed measuring point elevation data to construct water level contour maps for the hydrogeologic units of interest. These maps will be used to interpret groundwater flow conditions and to determine horizontal and vertical gradients in monitoring wells.

The objective of water level measurement is to provide data that are of sufficient quality to support decisions made during remedy design activities and that are representative of actual site conditions. The objectives of this task will be achieved by implementing QC procedures for water level measurement, by conforming to the approach specified in this FSP, and by conforming to specific QA objectives for water level measurement.

8.1 Equipment and/or Instrumentation

The QED® or Solinst® flat tape sounder is equipped with a plastic, laminated, two-wire cable with a weighted electrode attached to the end of the cable. The cable is graduated in markings every 0.01 foot. Alternate water level sounders can be used if they provide similar accuracy and precision as QED® or Solinst® flat tape sounders. The pressure transducer consists of a downhole probe constructed of stainless steel. Some transducers have a downhole communication cable and others are self-contained and hung from a stainless steel cable to secure the probe to the wellhead.

8.2 Preparation

Water level indicators, including QED® or Solinst® flat tape sounders, will be calibrated periodically by comparing a water level measured with the indicator against a water level measured with a steel tape or other water level indicator, and by checking the distances between the water level indicator markings with a steel tape (Form B-3).

The following procedures will be performed in preparation for monitoring water levels with flat tape sounders:

- Identify the wells to be measured.

- Identify the established measuring point for each well. The measuring point elevation will be determined by a licensed land surveyor. To the extent practical, the same measuring point at each well should be used (e.g., north side of casing or top of sounding tube) for all water level measurements.
- Review any previous water level measurements for each well.
- Decontaminate the water level indicator by using a nonphosphate detergent wash, followed by two tap water rinses and a distilled water rinse.

The following procedures will be performed in preparation for monitoring water levels with pressure transducers:

- Identify the wells to be equipped with pressure transducers. Identify required depth setting of transducer based on the expected range of water levels over the period during which the transducer will be installed in the well.
- Identify the type, appropriate pressure range, and model of pressure transducer to be equipped in monitoring wells and review the manufacturer's installation, set-up, and maintenance requirements.
- Identify and establish the measuring point for each well. The measuring point elevation will be determined by a licensed land surveyor.
- Identify and establish a pressure reading reference point for each well. Typically, the reference point is the depth to water at the time of pressure transducer installation.
- Determine time interval of measurement (e.g., on the hour, or on the quarter hour) and frequency of pressure readings. The time of measurement and frequency of pressure readings for wells equipped with pressure transducers should be equivalent across the Site.

8.3 Procedures

The following procedures will be used for measuring water levels with flat tape sounders:

- Measure the depth to water from the measuring point elevation twice for each well. The variation between the two consecutive measurements must be no more than 0.02 foot.

- For the QED® or Solinst® flat tape sounder, mark the water level and read the measurement from the marking on the flat tape.
- Record the depth to water, date, and time of measurement on the static water level data sheet (Form B-3). Examine previously measured water levels for the well. If the difference between the current water level measurement and the previous water level measurement is greater than approximately 1.0 foot, recheck the current measurement. The field personnel will indicate the method(s) of water level measurement and any rechecked water levels on the water level measurement form.
- Remove water level measurement equipment and decontaminate according to procedures outlined above.

The following procedures will be used when downloading pressure readings from monitoring wells equipped with pressure transducers:

- Download and save pressure readings from the transducer onto a portable computer.
- Review the recorded readings and check for consistency between readings.
- Synchronize the computer time with the transducer time.
- Check the available storage of the pressure transducer and the battery life. At least 50 percent of storage capacity should be available and 75 percent of the remaining battery life should remain.
- Manually measure the depth to water in the well using procedures described above. Record the manual depth-to-water measurement as described above. If the difference between the transducer reading and the manual reading is greater than 0.05 foot, re-set the reference point to the current measured depth to water.
- Upon return to the office, downloaded pressure transducer data must be copied onto a stationary computer. Corrections for potential transducer drift, based on manual water level measurements, are then applied to the data set.

8.4 Equipment Decontamination and Waste Disposal

Water level indicators and previously used pressure transducers and cable will be decontaminated by using a nonphosphate detergent wash, followed by two tap water rinses and a final, distilled water rinse. New pressure transducers and cable will require only a distilled water rinse.

8.5 Documentation

During monitoring events, water level measurements will be recorded on a static water level data sheet (Form B-3). The reported data will include depth to water in feet below the measuring point, a description of the measuring point, the date and time of the measurement, the calculated water level elevation, the method of measurement, and the initials of field personnel. Water level measurements will be reported to the nearest 0.01 foot.

All manually measured depth-to-water levels obtained from wells equipped with pressure transducers will be recorded on the static level data sheet. The comments section of the static water level data sheet will contain information regarding the downloading of the pressure transducers.

Calibration of the manual water level indicators will be documented on a separate form (Form B-4).

8.6 Quality Assurance

QA of manual water level measurement data will be accomplished by following the procedures described in this FSP. Calibration information will be entered onto the calibration form (Form B-4). In addition, the following QA procedures for water level measurements will be implemented:

- Measure water levels with a calibrated water level indicator. Prior to measuring water levels, verify that the instruments are properly calibrated.
- At each location and/or time interval, measure water levels a minimum of two times during routine water level measurement activities. Measure water levels until two consecutive measurements are obtained that have a difference of less

than 0.02 foot. Record the measurement on the static water level data sheet (Form B-3). Measure and record water levels to the nearest 0.01 foot.

- Compare measurement data to previous measurements obtained at the well. For variations from previous measurements greater than 1.0 foot or for data that cannot be explained by trends, repeat the measurements. If possible, use an alternative instrument to verify the accuracy of the data. Indicate the method(s) of water level measurement, the water level indicator or steel tape verification, and any rechecked water levels in the comments section on the static water level data sheet (Form B-3).

9. WATER QUALITY PARAMETER MEASUREMENTS

Prior to collecting groundwater samples for laboratory analysis, the water quality parameters electrical conductivity (EC), pH, dissolved oxygen (DO), turbidity, and temperature will be measured in water samples at each of the wells identified in Table B-1 to evaluate general water chemistry of the water sample. Stabilization of the parameters EC, pH, DO, oxidation-reduction potential (ORP), turbidity, and temperature will be indicative of representative water from the aquifer.

9.1 Equipment and/or Instrumentation

Water samples will be directed through a flow-through chamber or, if necessary, placed in a transfer bottle for measurement. Field equipment consists of a conductivity meter to measure EC, a pH meter to measure pH, a field thermometer to measure temperature, a DO meter to measure DO, an ORP tester to measure ORP, and a turbidity meter to measure turbidity. Some of these measurements are available as functions of an integrated instrument or "multi-meter".

9.2 Preparation

The probes on the conductivity meter, pH meter, DO meter, and ORP tester will be thoroughly rinsed with distilled water prior to each use. The pH meter will be calibrated in pH 4 and pH 10 buffered solutions prior to commencing field work each day. These pH values are expected to bracket the range of pH in groundwater samples collected from monitoring wells at the Site. The conductivity meter will be calibrated prior to commencing field work each day. The conductivity meter will be calibrated using standard calibration solutions selected to bracket the range of conductivity expected in water samples collected at the Site. The manufacturers' instructions for use of the instruments will be followed. The field thermometer will be rinsed with distilled water prior to each use. The accuracy of the field thermometer will be determined by checking the measured reading against other thermometers, if available. A calibration check of the DO meter will be performed by rinsing the probe in distilled water and taking an instrument reading in ambient air; the value should approach 10 milligrams per liter when corrected for temperature and pressure.

9.3 Procedures

A water sample will be directed through a flow-through chamber, placed in a transfer bottle, or parameters will be measured directly at the well discharge point. The parameters EC, pH, temperature, DO, ORP, and turbidity at each sampling location will be measured as follows:

- Calibrate the pH and conductivity meters to standard solutions.
- Rinse the transfer bottle, if used, with sample water prior to filling. Fill the transfer bottle with sample water.
- Immediately submerge the probes and thermometer in the transfer bottle and record measurements after they have stabilized. Continuous readings are possible if a flow-through chamber is used.
- Record all field measurements in the field notebook.
- Compare the present measurements to measurements taken during the previous sampling round, if available. If a discrepancy exists greater than can be expected for routine changes in groundwater quality, repeat the process.
- After parameters are measured, rinse the transfer bottle, thermometer, and probes with distilled water if a transfer bottle is used.
- Discard the water sample in the transfer bottle. This water will not be used to fill sample containers.
- Record parameters at least twice for each casing volume. Indicator parameter stabilization will be defined as three consecutive readings that meet the following stabilization criteria (California Environmental Protection Agency, Department of Toxic Substances Control [DTSC], 2008; EPA, 2002):

Parameter	Stabilization Criteria
Temperature	± 3% of reading (minimum of ± 0.2° Celsius)
pH	± 0.1
EC	± 3%
ORP	± 10 millivolts
DO	± 0.3 milligrams per liter

9.4 Equipment Decontamination and Waste Disposal

The transfer bottle, flow-through cell, and the probes used for measurement of field parameters will be decontaminated before and after each measurement by rinsing with distilled water. Rinsate will be collected and handled with purge water.

9.5 Documentation

Periodic measurements of EC, pH, temperature, DO, ORP, and turbidity for pumped wells will be recorded on the appropriate groundwater sampling information form (Form B-5). Calibration of the EC, DO, and pH meters will be documented on separate forms (Forms B-6 through B-8).

9.6 Quality Assurance

QA of water quality parameter measurements will be accomplished by following the procedures described in this FSP and by following the equipment manufacturers' operating instructions. Temperature, pH, EC, DO, ORP, and turbidity will be measured during each groundwater sampling event. Prior to measuring water quality parameters, field personnel will verify that the instruments are properly calibrated according to procedures specified by the manufacturer. Calibration documentation for each instrument will be maintained for reference purposes (Forms B-6 through B-8). Reference solutions for pH and electrical conductivity (EC) will be prepared and used to properly calibrate the instrument. The calibration of the DO meter, pH meter, and EC meter will be checked at the start of each day.

10. GROUNDWATER SAMPLE COLLECTION

Representative groundwater samples will be collected for chemical analysis in accordance with the Request for Analyses (Table B-1). Results of water quality analysis will be used to determine the chemical characteristics of the groundwater. Groundwater samples will be analyzed for the Main chemicals of concern (COCs), specifically volatile organic compounds (VOCs) using EPA Method 8260B; 1,4-dioxane using EPA Method 8270 SIM; and hexavalent chromium using EPA Method 218.6.

Representative groundwater samples for laboratory analysis will be collected from monitoring wells using the low-flow / minimal drawdown method, unless the physical conditions encountered at a well necessitate another method of groundwater sampling. The following major elements of the low-flow method are discussed in more detail in subsequent sections:

- Installation of the pump intake within the screened interval to ensure sampling of formation water within the contaminant zone;
- Purging at a sufficiently low flowrate, generally between approximately 100 to 500 milliliters per minute (ml/min), to minimize turbulence and ensure minimal drawdown, generally less than about 0.33 foot, in the well during purging and sampling with the goal of sustaining a sufficiently low flowrate to avoid causing continuous drawdown in the well;
- Frequent periodic or continuous monitoring of water level drawdown in the well during purging to minimize turbulence and any potential mixing with the overlying stagnant water column; ensure minimal drawdown; and reduce disturbance and stress to the water column in the well and the water-bearing zone being sampled;
- Frequent periodic or continuous monitoring of the field indicator parameters pH, temperature, EC, DO, ORP and turbidity to verify and document stabilization of these indicator parameters prior to collection of groundwater samples; and
- Collection of groundwater samples at a discharge rate that is the same or less than the purge rate.

The low-flow method will be conducted in general accordance with guidelines, methods, and procedures that include those provided by the California Department of Toxic

Substances Control (DTSC) and EPA (DTSC, 2008; EPA, 2002) (collectively the Guidance).

Other relevant logistical considerations include the manufacturer's specifications and operating instructions for the type of pump; pump and flow controller; water level indicator; and field parameter equipment used for purging and sampling.

The objectives of field measurement data have been specified for accuracy and completeness parameters in Section 9. These objectives will be achieved by conforming to this section and by implementing field measurement QC procedures.

Objectives for laboratory analysis will be achieved in the laboratory by applying control limits for QC samples, including matrix spike samples, matrix spike duplicate samples, laboratory duplicate samples, internal standards, surrogates, and laboratory control standards. Laboratory data quality will be assessed for precision, accuracy, representativeness, completeness, and comparability. Project-specific reporting detection limits will be, to the extent practicable, below the established State or Federal Primary or Secondary Maximum Contaminant Levels / Notification Levels for drinking water where applicable, or at or below State Water Resources Control Board Division of Drinking Water Detection Limits for purposes of reporting (please see detailed list of reporting limits in the Quality Assurance Project Plan [QAPP]). QC limits will be established after a California-certified laboratory has been selected. These limits will be either at or below those QC limits specified in the respective analytical method. Data assessment procedures in the QAPP will be used to determine the achievement of objectives for chemical analyses.

10.1 Equipment and Instrumentation

Sample containers required for collection of water samples for chemical analysis are specified in Table B-1.

A number of potentially suitable equipment and instrumentation options are available for purging and sampling using the low-flow method. Common elements of these options include:

- A water level measuring device capable of measuring water levels to the nearest 0.01 foot and monitoring drawdown periodically or continuously during purging;
- A purging and sampling pump and associated driver/controller mechanism capable of sustaining a pumping rate of about 100 ml/min without aerating the sample;
- Sufficient chemically compatible dedicated sample tubing, optimized to the degree practical to minimize total sample system volume by limiting both the total length and inside diameter of the tubing; and
- A flow-through cell and associated field parameter measurement devices for measurement and frequent periodic or continuous monitoring and recording of the field indicator parameters temperature, pH, EC, turbidity, ORP and DO.

Other basic equipment common to all purging and sampling methods includes necessary health and safety equipment; a stop watch and calibrated volumetric container for measuring and monitoring purge rate; a flow meter; a purge water container for temporary storage/staging of properly labeled and secured purge water; properly preserved sample containers; shipping containers; field data documentation forms, including labels and chain-of-custody; and decontamination supplies.

If the low-flow method cannot be used, a dedicated electric submersible pump or decontaminated Grundfos Redi-Flo2 electric submersible pump with dedicated tubing will be used to purge and sample monitoring wells. Alternatively, if the monitoring well has at least 1 foot of water but less than 3 feet of water above the bottom of the screened interval, a bailer can be used to purge and sample the monitoring well.

10.2 <u>Preparation</u>

Prior to commencing a sampling event, the following information will be determined and reviewed with all field personnel:

- Objective of the monitoring event
- Analytical schedule
- Water quality parameters to be measured

- Required frequency of measurement
- Laboratory selected for sample analysis
- Level of precision required
- Appropriate methodologies to accomplish objective
- QC samples required to accomplish objective

The following procedures will be used during preparation for groundwater sample collection:

- Review project objectives, sampling location, sampling procedures, preservation, special handling requirements, packaging, shipping, analytical parameters and detection limits, and sampling schedule with all personnel.
- Review health and safety procedures with field personnel.
- Follow Site access procedures, if applicable.
- Inform laboratory of expected sample shipment.
- Obtain the appropriate sample bottles from the laboratory.
- Obtain from the laboratory blank reagent-free deionized water for VOC analyses. When using nondedicated equipment in a well to be sampled, one equipment rinsate blank sample will be collected each day, at a minimum, for VOC analysis. The purpose of the equipment rinsate blanks is to identify potential cross contamination associated with inadequate decontamination of nondedicated equipment.
- Obtain from the laboratory trip blank water vials containing reagent-free deionized water for VOC analyses at a rate of two vials for each ice chest containing samples for VOC analysis. Trip blanks will be prepared by the laboratory using reagent-free deionized water. The purpose of the trip blanks is to identify potential contamination associated with container preparation and sample transport.
- Assemble all necessary equipment and supplies that will be required to complete the sampling event. Pumps, drivers, and controllers will be inspected and pre tested, as needed, prior to entering the field to ensure that they are in good repair

and fully functional. Field personnel will compile, review, and document the manufacturer's specifications for all parameter measurement equipment, including device-specific calibration methods, measurement-reading equilibration time, and maintenance requirements, to ensure that the field parameter equipment is fully functional, meets performance specifications, is properly calibrated, and can be properly maintained.

- Determine the minimum volume of water to be removed prior to sampling.

10.3 Procedures

The following procedures will be used for the collection of groundwater samples. If possible, the low-flow / minimal drawdown method will be used during the LEI activities.

10.3.1 Low-Flow / Minimal Drawdown Method

Because low-flow purge and sample methods draw groundwater from immediately adjacent to the pump intake, this method represents a depth-discrete sample rather than a composite sample of the entire saturated screen interval, which would be obtained by using the multiple casing volume method. Thus the pump set depth is an important consideration when using this method.

10.3.1.1 Pump Installation

Pump installation will either occur prior to the first sampling event, if dedicated systems are used, or prior to each sampling event, if non-dedicated systems are used. In either case, the initial pump installation will include testing the pump system to evaluate and record optimal purge rates and driver/controller settings based on each well's performance as determined based on measurements of drawdown and other field parameters, including turbidity, if available.

Prior to setting pumps in each well, all pumps and associated equipment will be thoroughly decontaminated in accordance with specific manufacturer's recommendations.

Pump-set depths will be determined in advance based on well construction specifications and hydrogeologic conditions at each well. The pump intake will generally be set at the middle of the saturated screened interval. Special consideration will be given to water table wells that exhibit a wide range of seasonal variation, in which case the pump intake may be set at a depth equivalent to the middle of the saturated screened interval during lower water level elevation conditions.

For a given well, the pump intake will be set at the same depth throughout the course of the monitoring program.

Pump systems will be installed with care by slowly and gently lowering the equipment to, but not beyond, the pre-determined pump set depth to minimize turbulence and disruption of the static water column above the pump intake, and to minimize disturbance of bottom sediments and the groundwater in the well adjacent to and below the pump intake.

After each initial pump installation, the pump system will be activated, and drawdown will be measured and recorded as the flowrate is adjusted to optimize non-turbulent flow and achieve minimal drawdown. The well-specific driver/controller settings corresponding to the optimal flowrate for achieving minimal turbulence and drawdown will be recorded for each well for use and further refinement during each subsequent purging and sampling event.

10.3.1.2 Purging

For each well to be sampled, field personnel will calculate and record the depth of the pump intake; the inner diameter and total length of the discharge tubing; and the total system volume for each system installation, which includes the sum of the volume of the pump, the volume of the discharge tubing, and the volume of the flow-through cell used to measure indicator parameters, compensated for the displacement volume of the parameter probes.

System volume will be recorded in the same units that discharge volume will be recorded during purging and sampling, generally milliliters or liters. To the extent practical, thick-walled discharge tubing will be used to minimize tubing/purge volumes. In no case will the purge volume at the time of sampling be less than twice the total system volume.

The overall goal when purging each well is to stabilize the flowrate as soon as possible to achieve the least amount of stress/turbulence and stabilize drawdown for purging and sampling, with a target drawdown on the order of about 0.1 meter (0.33 foot) or less. Purging will commence at the lowest flowrate possible to achieve and sustain continuous discharge at the surface, while simultaneously monitoring the water level to adjust flowrate downward to minimize drawdown. Measurements of discharge rate will be made using in-line flow meters and/or stop watches and graduated cylinders, beakers, or other calibrated small-volume containers sufficient for quantifying target flowrates that are typically on the order of about 100 ml/min to 500 ml/min. Drawdown will be calculated as the difference between the pumping water level and the pre-pumping static water level.

The actual flowrate and the minimal drawdown goal may be difficult to achieve under some circumstances due to hydraulic properties of the geologic formation within the screened interval. Adjustments may be required based on site and/or well-specific conditions, equipment, and/or personal experience. If the minimal drawdown cannot be maintained, the actual drawdown and flowrate will be monitored and documented on the field data documentation forms.

Indicator Parameter	**Stabilization Criteria**
Drawdown	Generally <0.1 meter (<0.33 foot)
Flowrate	Generally 100 to 500 ml/min
Temperature	+/- 0.2 degrees Celsius or +/- 3% of reading
pH	+/- 0.1 pH units
EC	+/- 3% of reading (mS/cm)
DO	+/- 0.3 mg/l
Turbidity	1 NTU or +/- 10% when turbidity is >10 NTUs
ORP	+/- 10mV

< = Less than; mS/cm = millisiemens per centimeter; mg/l = milligrams per liter; NTU = nephelometric turbidity unit; > = Greater than; mV = millivolts

In addition to drawdown and flowrate, indicator parameters will be continuously monitored during purging and sampling. Indicator parameters will be monitored using a flow-through cell of known volume and calibrated meters and probes. Frequency of monitoring for these parameters is a function of the total system volume and purge rate. Indicator parameter monitoring will commence after purging a minimum of one complete total system volume. The minimum time interval between subsequent indicator parameter readings will be equal to or greater than the time required to replace the internal volume of the flow-through cell plus the measurement/reading equilibration time, generally expected to be on the order of every 3 to 5 minutes. Indicator parameter stabilization will be defined as three consecutive readings after the initial system volume is removed that meet the following stabilization criteria as further detailed in the Guidance (DTSC, 2008; EPA, 2002).

Minimal flowrate, minimal drawdown, and indicator parameter stabilization will be confirmed as soon as possible after commencing purging. Documentation will be maintained in a detailed and well-organized format on the appropriate field data documentation forms (Forms B-3 through B-11).

10.3.2 Multiple Casing Volume Method

The following procedures will be used for the collection of groundwater samples using the multiple casing volume method:

- Measure depth to water in well to be sampled (Section 8).
- Determine the volume of water to be purged from the well. One casing volume is determined by multiplying the volume of water in 1 foot of well casing by the distance between the bottom of the well and the water level measured in the well.
- Purge the well until at least three casing volumes have been removed and the field parameter measurements pH, EC, and temperature have stabilized, provided that the well yields sufficient groundwater to remove three casing volumes within approximately 90 minutes. In the event that a well yield is insufficient, one casing volume will be purged. If one casing volume cannot be purged within 90 minutes, purge the well until the water draws down to the pump intake (typically set at the top of the screen, ensuring that a volume of water equivalent to the volume standing in the blank casing of the well above the screened interval will be purged) and discontinue pumping. The well should be allowed to recover for 2 hours after purging has stopped. Then the well should be sampled as soon after 2 hours as possible. In no event should a well be sampled more than 24 hours following completion of purging. Measure the water quality parameters to determine whether parameters have stabilized (Section 9).
- After purging is complete, collect water samples for laboratory analysis.

10.3.3 Sample Collection and Handling

- Record the following information on the field data sheet (Form B-5):
    - Static depth to groundwater
    - Time that bailing or pumping is started
    - Time of sample collection
    - Number of containers collected and analyses to be performed
    - Field parameter measurements for each purge volume
    - Field parameter measurements at time of sampling
    - Physical characteristics of the water including color, odor, turbidity, etc.
    - Total gallons removed at time of sampling
    - Total gallons removed at end of sampling.
- Collect water samples in appropriate sample containers from the pump discharge.
- Attach labels to sample containers immediately after samples are collected.
- General sample collection statements:
    - If sample bottles for analytes specified in this FSP contain preservatives or are sterile, do not rinse bottles; otherwise, triple-rinse unpreserved (not sterile) bottles prior to sample collection.
    - If samples are to be cooled, store on ice in ice chest immediately after collecting.
- Collect headspace-free water samples for VOC analysis in pre-acidified 40-milliliter (ml) glass sample vials preserved with hydrochloric acid. Do not rinse the glass vials with discharge water prior to sample collection. To avoid aeration, hold the glass vial at an angle so the stream of water flows down the side. To eliminate any air bubbles, fill the vial until it forms a meniscus and replace the Teflon-lined cap. Turn the vial upside down and tap it to check for air bubbles. If there is any headspace in samples collected for VOC analyses, discard the original vial and use a new pre-acidified vial. Repeat this procedure until a sample without headspace is obtained.

- Collect three 40-ml vials for each VOC analysis for each well sampled. Place samples in a resealable plastic bag and store on ice in an ice chest immediately after collection.
- Collect water samples for 1,4-dioxane analysis in 250-milliliter amber glass bottles with Teflon-lined caps. Do not rinse the amber glass bottles with sample water prior to sample collection. Store on ice in an ice chest immediately after collection.
- For priority pollutant metals, the samples can be collected filtered in the field or filtered in the laboratory as follows:
    - Field filtered samples: Filter water samples in the field prior to collection in preacidified bottles. Collect water samples for priority pollutant metal analysis in preacidified 1-liter polyethylene bottles preserved with nitric acid. If cations are collected from the same well at the same time, the priority pollutant metals can be obtained by the laboratory from the same bottle. Do not rinse sample bottles with discharge water prior to sample collection. Store on ice in an ice chest immediately after collection.
    - Laboratory filtered samples: Collect water samples for priority pollutant metals (and cations, if applicable) analysis in 1-liter polyethylene bottles. Triple-rinse unpreserved sample bottles with sample water prior to sample collection. Instruct laboratory to filter and acidify immediately upon receipt. Store on ice in an ice chest immediately after collection.
- Collect one field duplicate sample for every 10 samples collected during the sampling event. Analyze duplicate samples for the same compounds as original samples. Send duplicate samples along with the original samples to the primary laboratory. The location for duplicate sample collection will be determined prior to each sampling round.
- Collect one field blank sample daily or for every 10 samples collected during the sampling event, whichever is more frequent. Analyze field blank samples for VOCs. The field blank will be prepared at a sampling location by the field personnel using reagent-free deionized water obtained from the primary analytical laboratory.

- If nondedicated sampling equipment is used, collect one rinsate blank sample daily or for every 10 samples collected during the sampling event, whichever is more frequent. Analyze field blank samples for VOCs. The field blank will be prepared at a sampling location by the field personnel using reagent-free deionized water obtained from the primary analytical laboratory.
- Include one trip blank sample containing reagent-free deionized water for VOC analysis to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the primary analytical laboratory, using reagent-free deionized water.
- Prepare split samples for EPA or other agencies during groundwater sampling, if required, by alternately filling agency and project sample containers in sequential order for each parameter until all containers are filled.
- Handle duplicate, trip blank, and field blank water samples in a manner identical to other water samples.
- Record all pertinent data concerning each sample on the groundwater sampling information field data form (Form B-5).
- Record all pertinent data concerning each duplicate, split, and blank sample on the appropriate field data log forms (Forms B-9 and B-10).
- Complete chain-of-custody record at each sample location prior to sampling at the next sample location (Form B-11).
- Package, store, and transport the samples to the laboratory at the conclusion of each sampling day. Samples will be delivered to the laboratories as quickly as possible, via laboratory courier, if available.

10.4 Sample Containers, Preservation, and Transmittal

A list of the types and volumes of sample containers used for groundwater sampling in Table B-1. The laboratory will prepare the 40-ml glass vials and septa used to collect samples for VOC analysis. The vials will be washed with detergent, rinsed with organic-free water, and dried 1 hour at 105 degrees Celsius. Vials to be used for VOC analysis will be preserved with hydrochloric acid. These vials will not be rinsed with sample water prior to collection of samples.

Upon collection, all samples will be sealed with custody seals, labeled, and stored on ice in ice chests until received by the laboratory. Sample shipments will contain completed chain-of-custody records stored in resealable plastic bags for shipment to the laboratory (Form B-11). Each ice chest containing samples will be clearly labeled and sealed to prevent tampering. Standard sample control and chain-of-custody procedures will apply.

10.5 Equipment Decontamination and Waste Disposal

Nondedicated downhole equipment will be decontaminated between monitoring wells to be sampled during the Work Area activities by using a nonphosphate detergent wash, followed by a potable water rinse and a final, distilled water rinse.

Water generated during decontamination procedures will be containerized and stored on-Site. Spent health and safety equipment will be containerized and stored on-Site.

Purge water from monitoring wells will be contained at the wellhead and transported to a storage tank or other designated purge water storage container at a location to be determined. Disposal of purge water practices will be consistent with Section 11 for handling, storage, characterization, and disposal of IDW.

10.6 Documentation

A record of sample identification numbers will be maintained on standardized field data forms (Forms B-9 through B-11). Additional field data include a record of significant events, observations, measurements, personnel, site conditions, sampling procedures, measurement procedures, and calibration records.

All field data entries in the field log will be signed, dated, and kept as a permanent record. Erroneous entries will be corrected by crossing a line through the error and entering the correct information. Corrections will be initialed by the person making the re-entry.

Sample identification documents will be prepared so that sample identification and chain-of-custody are maintained and sample disposition is controlled. Standard sample identification labels and chain-of-custody records will be used to record all information. Sample documentation forms and labels will be completed with waterproof ink. The sample documentation forms will accompany the samples to the laboratory. Copies of the sample documentation forms will be retained by the samplers and sent directly to the QA Manager designated for the project.

Preprinted adhesive sample labels will be secured to the sample containers by field personnel. The following information will be recorded on the sample label:

- Sample location/identifier
- Depth at which sample was collected, if applicable
- Date and time sample was collected
- Analyses to be performed
- Preservation instructions
- Project number
- Sampler's initials
- Any other pertinent information
- Any special instructions to laboratory personnel

Official custody of samples will be maintained and documented from the time of sample collection until the validation of analytical results. The chain-of-custody record is the document that records the transfer of sample custody. The chain-of-custody record also serves to cross reference the sample identifier assigned by the QA Manager with the sample identifier assigned by the laboratory. The chain-of-custody record includes the following information:

- Sample location/identifier

- Project number
- Sampling date
- Sampling personnel
- Shipping method
- Sample description
- Sample volume
- Number of containers
- Sample destination
- Preservatives used
- Analyses to be performed
- Special handling and reporting procedures
- The identity of personnel relinquishing and accepting custody of the samples

The sampling personnel will be responsible for the samples and will sign the chain-of-custody record to document sample transferal or transport. Samples will be packaged in sealed containers for transport and dispatched to the appropriate laboratory for analysis with a separate chain-of-custody record accompanying each shipment. The method of transport, courier name(s), and other pertinent information will be entered on the chain-of-custody record. During transport, samples will be accompanied by the chain-of-custody record.

Once received at the laboratory, laboratory custody procedures apply. It is the laboratory's responsibility to acknowledge receipt of samples and verify that the containers have not been opened or damaged. It is also the laboratory's responsibility to maintain custody and sample tracking records throughout sample preparation and analysis.

10.7 Quality Assurance

QA for groundwater samples collected during routine groundwater monitoring will be accomplished by following the procedures described in this FSP and by monitoring laboratory QA procedures. Laboratory QA procedures are specified in the laboratory's QA Manual, and evaluation of laboratory QA documentation is described in the Quality Assurance Project Plan (QAPP). In addition, the following field QC methods will be implemented during sample collection:

- Collect one field duplicate sample for every 10 samples collected during the sampling event. Send duplicate samples along with original samples to the primary laboratory. The purpose of the duplicate sample is to determine the precision of field sampling and laboratory analysis techniques. Field duplicate samples will be laboratory blind duplicates. A false well identifier will be assigned for the sample identifier and recorded on the sample label and chain-of-custody record along with a false sample collection time. The actual sample location, sample time, and corresponding false sample identifier and sample time will be recorded on the duplicate sample log form (Form B-10).
- Collect one equipment rinsate blank sample each day or for every 10 samples collected, whichever is more frequent, if nondedicated sampling equipment is used in one or more wells. Equipment rinsate samples will be analyzed for VOCs. If laboratory analysis of the equipment rinsate sample indicates inadequate decontamination procedures, corrective action will be taken as detailed in the QAPP. Record blank sample preparation on the appropriate field form (Form B-9).
- Collect one field blank sample each day during the sampling event or for every 10 samples collected, whichever is more frequent. Sampling personnel will prepare the field blanks at a predetermined sample location using organic-free water obtained from the analytical laboratory. The purpose of the field blank is to identify possible contamination associated with sample collection and transport. Record blank sample preparation on the appropriate field form (Form B-9).
- Include one trip blank sample containing reagent-free deionized water for VOC analyses to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the analytical laboratory using reagent-free

deionized water. The purpose of the trip blank is to identify possible contamination associated with container preparation and sample transport.

- Prepare split samples for EPA or other agencies during groundwater sampling, if required, by alternately filling agency and primary sample containers in sequential order for each parameter until all containers are filled.
- Identify duplicates and blank samples in the same manner as all other samples. Identifiers will be determined prior to the sampling round and will be indicated in the sampling memorandum issued to field sampling personnel prior to the start of sampling activities.
- Prior to the start of each sampling round, the Project Manager will determine the sampling locations for field blank preparation and duplicate sample collection. Additionally, the field personnel will specify labeling procedures for these samples. This information will be contained in a sampling memorandum issued to field sampling personnel prior to the start of sampling activities.

11. HANDLING, STORAGE, CHARACTERIZATION, AND DISPOSAL OF INVESTIGATION-DERIVED WASTES

Wastes generated during this investigation will include water, soil, drilling fluid, and disposable personal protective equipment/sampling equipment.

A central staging area for temporary storage of IDW and/or decontamination of sampling equipment will be established within the Work Area. The central staging area will have sufficient area for managing IDW in 55-gallon drums, roll-off bins and/or temporary aboveground storage tanks (collectively referred to as IDW containers). The field personnel will work with the Project Coordinator to develop and document the unique IDW container Identification Numbers (included with each IDW container), dates of IDW placement into the container, the location of the container, and the date when the container was sampled for waste characterization.

A sticker/label that reads ‘This Container On Hold Pending Analysis’ will be affixed to the outside of each IDW container once IDW is first placed in them. The sticker/label will detail the appropriate contact information. If the waste is found to be hazardous, the label will be changed to read “Hazardous Waste”.

Analytical results of groundwater sampling will be used to characterize water generated during field activities. Additional analyses of temporarily stored IDW may be required to complete waste characterization, depending on disposal requirements.

Representative samples for waste profiling will be collected from consolidated IDW containers and submitted to a California-certified laboratory for analysis in accordance with California Code of Regulations, Title 22, Section 66261.24. Following waste profiling, the IDW will be transported by a licensed waste hauler for disposal at an appropriately permitted solid or hazardous waste facility in accordance with Federal and State requirements. IDW will be stored for no more than 60 days during characterization and consolidation.

12. REFERENCES

American Society for Testing and Materials (ASTM), 2000. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), D2488-00. West Conshohocken, Pennsylvania: American Society for Testing and Materials. 2000.

American Society for Testing and Materials (ASTM), 1986. Annual Book of ASTM Standards, Volume 04.08, D2488-84. Philadelphia, Pennsylvania: American Society for Testing and Materials.

California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), 2008. Representative Sampling of Groundwater for Hazardous Substances – Guidance Manual for Groundwater Investigations. July 1995, Revised February 2008.

Compton, R.R., 1962. Manual of Field Geology. New York: John Wiley & Sons.

U.S. Department of Interior, Bureau of Reclamation, 1998. Earth Manual, Part I. Third Edition. Washington, D.C.: U.S. Government Printing Office.

U.S. Environmental Protection Agency (EPA), 2002. Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, OSWER, EPA-S-02-001. Ground Water Forum Issue Paper. May 2002.

EPA, 2016. Consent Decree regarding Operable Unit 2 at the Omega Chemical Corporation Superfund Site, Case 2:16-cv-02696 Document 4-1. Filed with United States District Court, Central District of California, Western Division. April 20, 2016.

Walker, J.D., and H.A. Cohen (eds.), 2009. Geoscience Handbook: The AGI Data Sheets, 4th (revised) Edition. Falls Church, Virginia: American Geological Institute.

TABLE

Table B-1
Request for Analyses for Groundwater Samples*
Omega Superfund Site
Operable Unit 2

ANALYSES REQUESTED		Volatile Organic Compounds	1,4-Dioxane	Chromium VI
METHOD		EPA 8260B	EPA 8270C SIM	EPA 218.6
LABORATORY		Eurofins Calscience, Inc.		
CONTAINER TYPE		40ml VOA Vial	1L Amber	250ml Poly
PRESERVATIVES		4° C, HCl, pH <2	4° C	4° C
ANALYTICAL HOLDING TIMES		14 days	7days/40 days	24 hrs[a]
NO. CONTAINERS PER ANALYSIS		3	1	1
SAMPLE LOCATION	SAMPLING SCHEDULE			
Sampling Points				
Wells to be installed as part of the LEI				
LEI Well Cluster Location 1	Quarterly for 3 quarters following well installation[b]	TBD	TBD	TBD
LEI Well Cluster Location 2	Quarterly for 3 quarters following well installation[b]	TBD	TBD	TBD
LEI Well Cluster Location 3	Quarterly for 3 quarters following well installation[b]	TBD	TBD	TBD
QA/QC Samples				
Equipment Blanks[c]	Quarterly for 3 quarters following well installation[b]	1 per day or 1 per every 10	1 per day or 1 per every 10	1 per day or 1 per every 10
Field Blanks[d]	Quarterly for 3 quarters following well installation[b]	--	--	--
Trip Blanks	Quarterly for 3 quarters following well installation[b]	1 per cooler	--	--
Duplicates[e]	Quarterly for 3 quarters following well installation[b]	1 per every 10	1 per every 10	1 per every 10

Notes:
* - This table will be updated following the installation and sampling of the LEI wells.
a - If sample is field filtered and stored in ammonia sulfate buffer preservative, 28-day hold times are permitted.
b - LEI wells will be added to the WAMP upon completion of the three quarterly of initial sampling under the scope of the LEI.
c - One equipment rinsate blank will be collected per matrix each day that sampling equipment is decontaminated in the field or for every 10 samples collected, whichever is more frequent.
d - Field blanks will be collected daily when dedicated equipment is used and equipment (rinsate) blanks are not collected.
e - Duplicate samples will be collected at a rate of 10 percent of the samples collected.
°C - degree Celsius
EPA - United States Environmental Protection Agency
HCl - hydrochloric acid
L - Liter
LEI - Leading Edge Investigation
ml - milliliter
QA/QC - quality assurance/quality control
TBD - To be determined
VOA - volatile organic analysis
WAMP - Work Area Monitoring Plan

FIGURES

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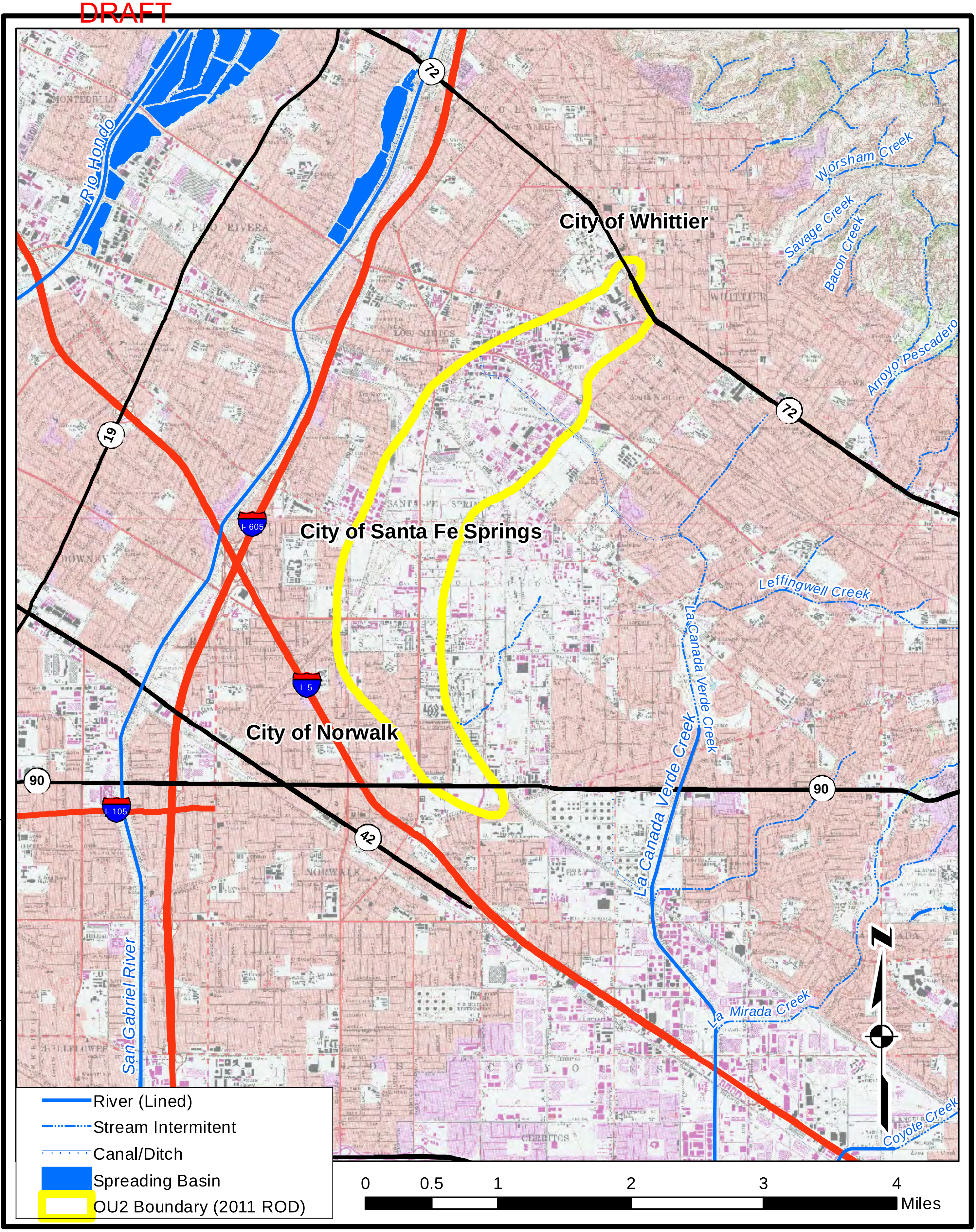

Document Name: 1217 CWP Fig01 SiteLocation F00 Date Exported: 8/15/2016

HARGIS + ASSOCIATES, INC
Hydrogeology/Engineering

FIGURE B-1. SITE LOCATION

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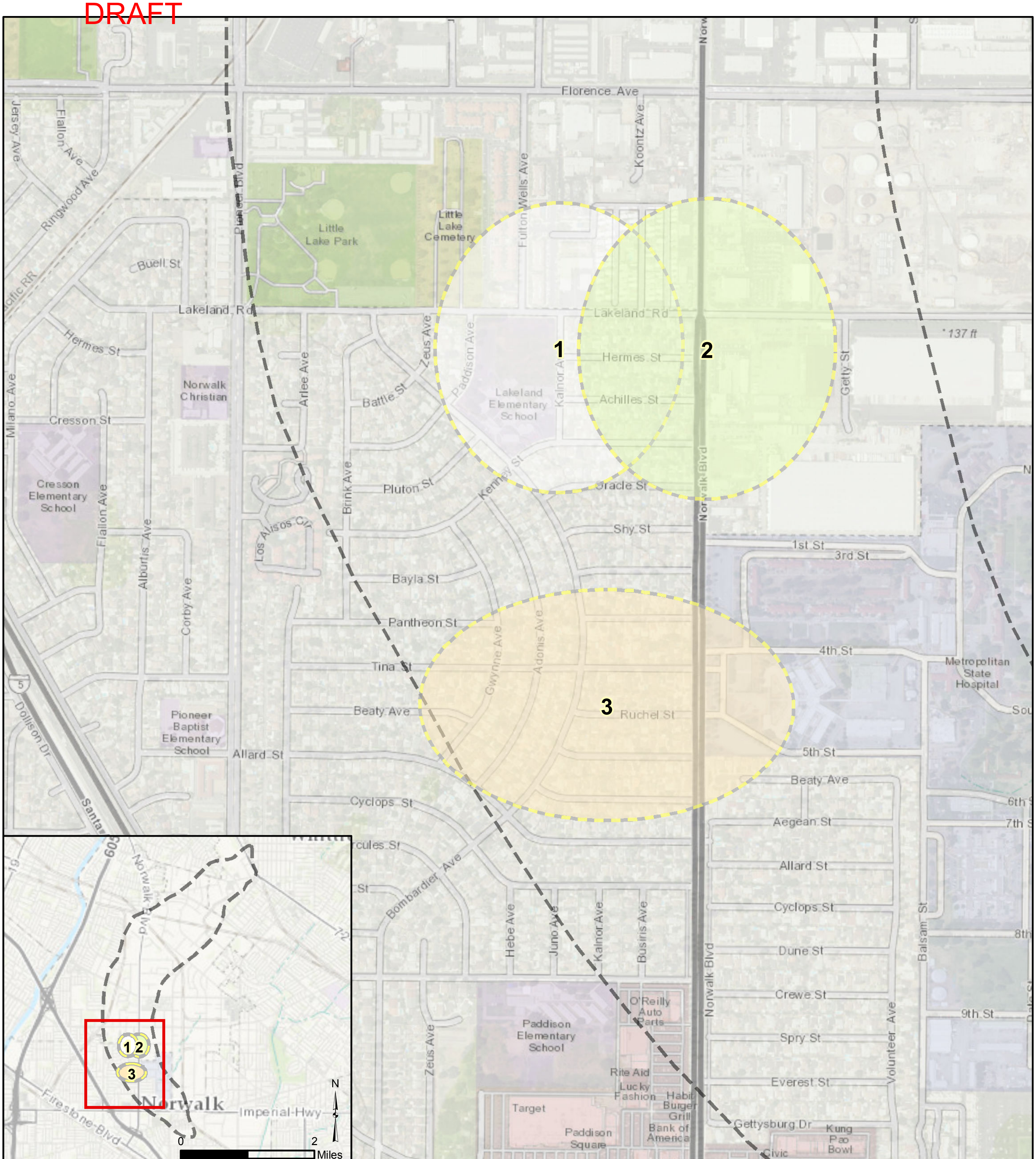

Legend

Proposed Monitoring Well Cluster

Operable Unit 2 (OU2) Boundary

N

0 800 Feet

Proposed Well Cluster Locations

Omega Superfund Site - OU2
Los Angeles County, California

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Figure B-2

WR2209	August 2016

\\oakland-01\data\GIS\Omega\Project\2016\2016_LEIworkplan\Fig-02_ProposedLocations.mxd 7/25/2016 4:54:15 PM

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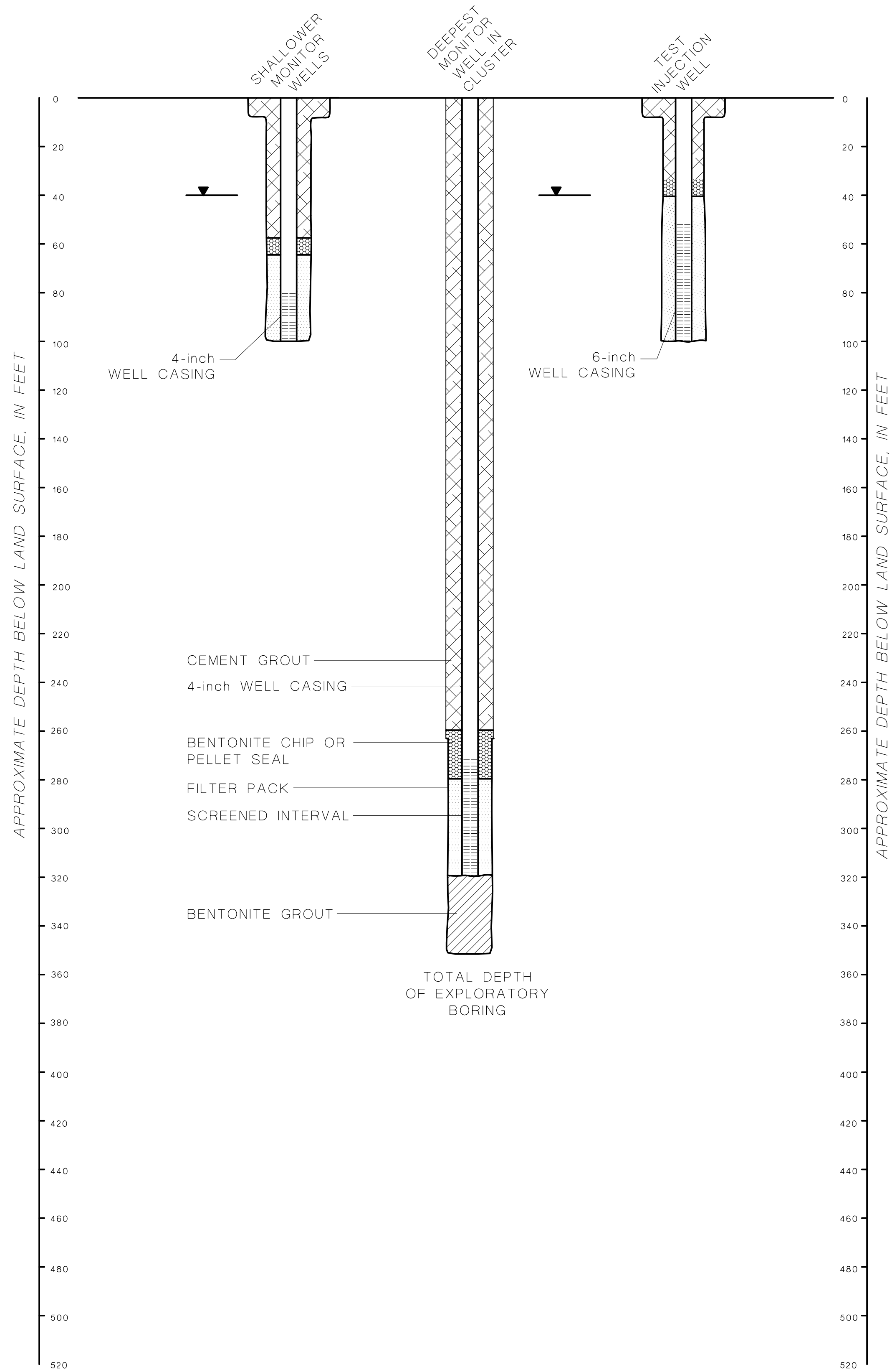

NOTE: ACTUAL DEPTHS TO BE DETERMINED

Jul 26, 2016 – 1:43pm ess – T:\2016\1000-1099\1098 Omega\Hydrogeology\Well Diagrams\710-0896.dwg

7/16	RPT NO. 1098.105	710–0896	A

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FIGURE B-3
SCHEMATIC WELL CONSTRUCTION DIAGRAM

ATTACHMENT B-1

Field Forms

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FORM B-1
LITHOLOGIC LOG FORM

BOREHOLE ID:	LOCATION:		PAGE 1 OF
PROJECT NO.:	PROJECT NAME:	LOGGED BY:	
WEATHER:			DATE(S):
DRILLING METHOD, EQUIPMENT:			HOLE DIA.:
DRILLING CONTRACTOR:		OPERATOR:	
SAMPLING METHOD, EQUIPMENT:			
SURFACE ELEVATION: ft/msl	TOTAL DEPTH: ft/bls	DTW: ft/bmp	
REMARKS:			

SAMPLES	CORE RECOVERY	DEPTH (feet bls)	GRAPHIC LITHOLOGY	USCS GROUP SYMBOL	LITHOLOGIC DESCRIPTION Textural classification (modifier, root), Munsell color descriptor (value), moisture content, consistency or relative density, plasticity, grain size, sorting, roundness, miscellaneous properties.	NOTES, REMARKS, OBSERVATIONS
		0				

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FORM B-1
LITHOLOGIC LOG FORM

BOREHOLE ID:	LOCATION:		PAGE OF
PROJECT NO.:	PROJECT NAME:	LOGGED BY:	
WEATHER:			DATE(S):

SAMPLES	CORE RECOVERY	DEPTH (feet bls)	GRAPHIC LITHOLOGY	USCS GROUP SYMBOL	LITHOLOGIC DESCRIPTION Textural classification (modifier, root), Munsell color descriptor (value), moisture content, consistency or relative density, plasticity, grain size, sorting, roundness, miscellaneous properties.	NOTES, REMARKS, OBSERVATIONS

ft/bls = Feet below land surface; ft/bmp = Feet below measuring point;
DIA = Diameter; USCS = Unified Soil Classification System
ft/msl = Feet mean sea level; DTW = Depth to water

FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

COMPLETION REPORT FOR WELL __________

Drilling Company: ______________________________

Driller: ______________________________

Drill Rig: ______________________________

Date drilling started: ______________________________

Date drilling completed: ______________________________

Description of drilling ______________________________

____

____

A. GENERAL

Location: ______________________________

Location coordinates: x ____________ y ____________

Total depth of borehole: ______________________________ feet bls

Borehole diameter: ______________ inches, from ____________ to ___________ feet bls

______________ inches, from ____________ to ___________ feet bls

Lost circulation zones: ______________________________

Lithology logged by: ______________________________

B. CONSTRUCTION

Conductor Casing

Type: ______________________________ , O.D.: __________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Centralizers/Shoe: ______________________________

FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name __________________________

COMPLETION REPORT FOR WELL __________

Well Casing

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Well Screen

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Type: ____ , O.D.: _________

Wall thickness: _________________ , from ______________ to ______________ feet bls

Centralizers/Shoe: ____

C. GROUT AND CEMENTING RECORD

Annular space: ____

Type of cement/grout: ____

Method of emplacement: ____

Approximate number of yards/bag: ____

Comments: ____

____

____

Annular space: ____

Type of cement/grout: ____

Method of emplacement: ____

Approximate number of yards/bag: ____

Comments: ____

____

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FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name ___________________________

COMPLETION REPORT FOR WELL __________

D. **GRAVEL PACK**

Type: ________________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: ________________________

Type: ________________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: ________________________

Grout Filter

Type: ________________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: ________________________

Bentonite Seal

Type: ________________________________ , from ___________ to ___________ feet bls

Volume emplaced: _________________ , Method emplaced: ________________________

E. DEVELOPMENT RECORD

Date: ____

Procedure: ____

Duration: ________ minutes

Procedure: ____

Duration: ________ minutes

Pumping duration: ________ minutes

Average pump discharge rate: _______ gpm

Drawdown at end of pumping: ________ feet bls

Field parameters (initial): pH _______________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

Field parameters (final): pH ________________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

COMPLETION REPORT FOR WELL __________

F. PUMP INSTALLATION DATA

Pump installer: ____

Installation date: _______________

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Surface completion (hole vault type, etc.): _______________________________________

G. REFERENCE ELEVATIONS

Land surface elevation: ____________ feet msl

Measuring point elevation: ____________ feet msl

Description of measuring point: ____

Date surveyed: _____________, by: ____

H. COMMENTS AND NOTES RE DRILLING WELL CONSTRUCTION OPERATIONS

____

____

____

____

____

FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name __________________________

MONITOR WELL PLACEMENT FORM

Proposed Well ID:__________________________ Actual Well ID: ________________________

Date:____________________________________ By: __________________________________

Street Address or APN: ____

City/Town: ____

Nearest Cross Street: ____

Thomas Brothers Reference: ____

Owner/Jurisdiction: ____

County Permit No. : ____

USA Alert Ticket: ____

Comments:____

____

____

Sketch Map

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FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

DEVELOPMENT REPORT FOR WELL ______

A. DEVELOPMENT REPORT

Well Type: ______________________________

Development Company: ______________________________

Developer/Helper: ______________________________

Development Rig: ______________________________

Date of Development: ______________________________

Field Notebook: ______________________________

Personnel: ______________________________

Description of Development: ______________________________

____

____

____

B. WELL DEVELOPMENT

Total Well (Driller): ______________________________ feet bls

Depth to bottom of well before development: ____________________ feet bls

Bottom: soft, medium, hard

Depth to water before development: ____________________ feet bls

Procedure: ______________________________

Duration: ________ minutes, Comment: ______________________________

Procedure: ______________________________

Duration: ________ minutes, Comment: ______________________________

Procedure: ______________________________

Duration: ________ minutes, Comment: ______________________________

Procedure: ______________________________

Duration: ________ minutes, Comment: ______________________________

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FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

DEVELOPMENT REPORT FOR WELL ______

Procedure: ____

Duration: ________ minutes, Comment: ____

Pumping duration: ________ minutes

Field parameters (initial): pH _______________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

Average pump discharge rate: ___________ gpm Gallons purged: _________________

Depth to water at end of pumping: ______________ feet bls, Drawdown __________ feet

Specify Capacity: ____________________ gpm/ft

Field parameters (final): pH ________________ , Conductivity _____________ (umhos),

Temperature _____ (°C), Turbidity ____

Depth to bottom of well after development: _______________________________ feet bls

Bottom: soft, medium, hard

Depth to water after development and recovery: ___________________________ feet bls

Measured: ___________________ hours after final pumping

C. PUMP INSTALLATION DATA

Pump installer: ____

Installation date: ____

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Pump purpose/type: ____

Pump model/specs: ____

Pump setting: ____

Comments: ____

____

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FORM B-2
WELL COMPLETION AND DEVELOPMENT REPORT

Project No. ____________

Project Name _________________________

DEVELOPMENT REPORT FOR WELL ______

D. SURVEY DATA

Surveyor: ____

Date surveyed: ____

Land surface elevation: _____________ feet msl

Measuring point elevation: ____________ feet msl

Location coordinate: x _________________________ y _________________________

Description of measuring point: ____

E. COMMENTS

____

____

____

____

____

____

____

____

FOOTNOTES

°C = degrees Celsius
bls = Below land surface
msl = Mean sea level
O.D. = Outer Diameter
umhos = Micromhos
ID = Identifier
APN = Assessor's Parcel Number
gpm = Gallons per minute

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FORM B-3
STATIC WATER LEVEL DATA SHEET

MONTH/YEAR: ______________________

PROJECT NUMBER: ______________________

METHOD OF MEASUREMENT/SOUNDER IDENTIFIER: ______________________

WELL IDENTIFIER	DATE	TIME	MEASURING POINT	DEPTH TO WATER FROM REFERENCE POINT (± feet)	REFERENCE POINT ELEVATION (± feet msl)	WATER LEVEL ELEVATION (± feet msl)	PREVIOUS DEPTH TO WATER (feet)	CHANGE IN WATER LEVEL (± feet)	COMMENTS	INITIALS

Msl = Mean sea level

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FORM B-4
WATER LEVEL INDICATOR
CALIBRATION DOCUMENTATION FORM

PROJECT NUMBER:______________

DATE	TIME	WATER LEVEL INDICATOR TYPE	WATER LEVEL INDICATOR NUMBER	CALIBRATION METHOD	CALIBRATED BY (INITIALS)	REMARKS

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FORM B-5
LOW-FLOW GROUNDWATER SAMPLE FORM

DATE: ____________________ **TASK:** ____________________ **WELL ID:** ____________________

SELECT TUBING SPECS	
TUBING DIAMETER	TUBING CAPACITY
3/8" X 1/2"	22 mL/ft
1/4" X 3/8"	9.7 mL/ft
0.17"ID	4.5 mL/ft

Calculate System Volume

Length of tubing: _______ ft x Capacity of Tubing: _______ mL/ft

Tubing Volume = _______ L

\+ Vol of flow-thru cell:_______ L

\+ Vol of pump:_______ L

Total Vol of System = _______ L x 2 = **Min. Purge Volume =** _______ L

Initial Measurements

Static Depth to water: ____________ ft brp

Well Total Depth: ____________ ft brp

Screened Interval : _____ to _____ ft brp

Pump Intake : ____________ ft brp

brp description (circle one): TOC LS other

Purge Summary Initials: _______________

Begin Purge: ________ End Purge: __________

Tot. Vol Purged: ________L SVs purged: _________

Weather Conditions Time: ___________

Temp. ________°F Skies _______________

Wind ________ mph From_____________

Pump Type (circle one) : ___ **Bladder pump** ___ **or** ___ **Peristaltic Pump**

Time	Flow Controller Settings	Depth to Water (ft brp)	Flow Rate (mL/min)	Volume Purged (L)	System Volumes Purged	....FIELD PARAMETERS.... Temp. (°___) +/- 3%	Ph units +/- 0.1 unit	EC (___S/cm) +/- 3%	O.R.P. (mV) +/- 10 mV	D.O. (mg/L) +/- 0.3mg/L	Turbidity (NTU) +/- 10% (if > 10NTU)	COMMENTS

SAMPLE COLLECTION SAMPLE TIME ____________________

ANAYSIS	QUANTITY	TYPE
VOCs by EPA 8260B		40 mL VOA w/ HCl
1,4-Dioxane by EPA 8260B MOD		40 mL VOA w/ HCl

DUPLICATES / BLANKS? Y N

If yes, complete appropriate forms.

AIR MONITORING PID/FID ppm: VAULT __________BKGD___BREATHING ZONE___DISCHARGE WATER____________

NOTES (Color, odor, sand and silt content, factors possibly affecting samples, condition of vault, wellhead, sampling apparatus, etc.)

Acronyms and Abbreciations: SVs = System Volumes; brp = below reference point; mL = milliliters; gal = gallons; L = liters; DTW = depth to water; TD = total depth

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PROJECT ____________

FORM B-6
INSTRUMENT CALIBRATION LOG FOR GROUNDWATER SAMPLING: EC METER

DATE	TIME	EC SOLUTION ( )	TEMPERATURE OF SOLUTION	EC READING ( )	CORRECTION FACTOR	METER TYPE	COMMENTS	INITIALS

EC = Electrical conductivity

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PROJECT ____________

FORM B-7
INSTRUMENT CALIBRATION LOG FOR GROUNDWATER SAMPLING: pH METER

DATE	TIME	pH BUFFER (units)	TEMPERATURE OF BUFFER	pH READING (units)	CORRECTION FACTOR	METER TYPE	COMMENTS	INITIALS

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PROJECT ___________

FORM B-8
INSTRUMENT CALIBRATION LOG FOR GROUNDWATER SAMPLING: DISSOLVED OXYGEN METER CALIBRATION (AIR METHOD)

DATE	TIME	METER MODEL	TEMP (ºC)	ELEVATION (ft msl)	SOLUBILITY OF OXYGEN	ALTITUDE CORRECTION FACTOR	CALIBRATION VALUE[(a)] (mg/l)	COMMENTS	INITIALS

(a) Calibration value determined by multiplying solubility value by altitude correction factor

°C = Degrees Celsius
ft msl = Feet mean sea level
mg/l = Milligrams per liter

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FORM B-9
BLANK SAMPLE LOG FORM

PROJECT NUMBER:________________________

MONTH/YEAR:________________________

PAGE _______OF________

DATE	TYPE BLANK (Trip or Rinsate)	SAMPLE IDENTIFIER	TIME	PREPARATION LOCATION	ANALYTICAL METHOD	BLANK WATER SOURCE & DATE	BATCH NUMBER	COMMENTS AND SAMPLING CONDITIONS	INITIALS

FORM B-10
DUPLICATE/SPLIT SAMPLE LOG FORM

SAMPLE DATE	SAMPLE TIME ACTUAL/REPORTED	SAMPLE LOCATION	SAMPLE IDENTIFIER	ANLAYTICAL METHOD	COMMENTS	INITIALS

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FORM B-11

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CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST FORM

DATE ________ PAGE ____ OF ____

PROJECT NAME	PROJECT No./TASK No.	SAMPLE CONTAINERS	ANALYSIS REQUESTED	ESTIMATED CONCENTRATION RANGE (ppb) FOR VOA'S	SPECIAL HANDLING	LABORATORY INFORMATION
PROJECT MANAGER	Phone No.					
QA MANAGER	Fax No.					
SAMPLER (SIGNATURE)	SAMPLER (PRINTED)					

LAB ID	SAMPLE ID	SAMPLE COLLECTION		MATRIX			PRESERVATION					REMARKS
		Date	Time	Soil	Ground water	Surface water	HCl	HNO_3	NaOH	H_2SO_4	Ice	

Total number of Containers per analysis:

Total No. of Containers: ________

Relinquished by:	Date	Received by:	Date
	Time		Time
Company		Company	
Relinquished by:	Date	Received by:	Date
	Time		Time
Company		Company	

INSTRUCTIONS

1. Fill out form completely except for shaded areas (lab use only); sign only after verified for completeness.
2. Complete in ballpoint pen. Draw one line through errors, initial and date correction.
3. Indicate number of sample containers in analysis request space; indicate choice with ✓ or x.
4. Note applicable preservatives, special instructions, and deviations from typical environmental samples.
5. Consult project QA documents for specific instructions.

Sample Receipt: **Temp. @ receipt ________ °C**

- ☐ **No. of containers correct**
- ☐ **received good condition/cold**
- ☐ **custody seals secure**
- ☐ **conforms to COC document**

Shipment Method: ________

Send Results to: ________

- ☐ 9171 TOWNE CENTRE DRIVE, SUITE 375 SAN DIEGO, CA 92122 (858) 455-8500
- ☐ 1640 SOUTH STAPLEY DRIVE, SUITE 209 MESA, AZ 85204 (480) 345-0888
- ☐ 7400 NORTH ORACLE ROAD, SUITE 202 TUCSON, AZ 85704 (520) 881-7300

Send invoice to San Diego, CA
Attn: Accounts Payable

ORIGINAL: LABORATORY **YELLOW: QA MANAGER** **PINK: FIELD/TASK MANAGER**